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ABSTRACT

Following a brief review of the terminology, important research, and distinguishing characteristics of game theory, four potential benefits of a game theoretic approach to communication research are proposed; game simulations facilitate communication process research; a game matrix enables the researcher to simulate situations in which communication functions as an essential determinant of behavior; use of game simulations permits the precise measurement of behavioral choices which result in real gains and losses; and game simulations in communication research necessitate a clear definition of communication and how it differs from other behaviors. The paper also includes a description and extended discussion of the "creative alternative" game and a summary of programmatic empirical research on communication in game simulations. Further questions for research are proposed at the conclusion of the paper. (Author/RB)

GAME THEORY AND COMMUNICATION PROCESS RESEARCH

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ABSTRACT

This paper is comprised of four sections. At the outset, the authors briefly review terminology, important research, and distinguishing characteristics of game theory. In the following section, it is proposed that four potential benefits for our discipline accompany the adoption of a game theoretic perspective in communication research: (1) game simulations facilitate communication process research; (2) a game matrix enables the researcher to simulate situations in which communication functions as an essential determinant of behavior; (3) use of game simulations permits precise measurement of behavioral choices which result in real gains and losses; (4) game simulations in communication research necessitate a clear definition of communication and how it differs from other behaviors. The third part of the paper contains a description and extended discussion of the Creative Alternative game, as well as a summary of programmatic empirical research by the authors on communication in game simulations. Further questions for research are proposed at the conclusion of the paper.

GAME THEORY AND COMMUNICATION PROCESS RESEARCH

Introduction:

The purpose of this paper is fourfold: (1) to review briefly distinguishing characteristics of game theory; (2) to suggest the utility of this theoretic and methodological approach in the scientific study of the communication process; (3) to present a game simulation which has proved particularly helpful in our communication research and to summarize these experimental findings; (4) to propose questions for future research. As indicated by the section headings which follow, these four topics are discussed sequentially.

Game Theory:

Game theory originated with the now classic work of economists von Neumann and Morganstern (1947), which was the first truly mathematical theory developed by the social sciences. Ironically, however, the theory was normative rather than descriptive; that is, game theory was intended to recommend behavior--not to explain or predict it. Game theory describes only how an ideal concept called rational man behaves, and by extension how any player acting rationally in a given situation ought to behave. Rational man operates on the "mini-max principle": he acts so that he will minimize his losses and maximize his gains in any situation, without regard for the losses or gains of others.

To know whether a given act is rational in the game theory sense, that which is rewarding to a person (and that goal which the act is directed) must be determined. This definition may take several forms. We may define a reward a priori by recourse to social-cultural values. We may define the utility phenomenologically by determining what is of value to the actor (irrespective of

social norms) and making an inference from this value to the object or act reward. Or the reward value of the object or act can be defined behaviorally by observing the agent's behavior with relation to the object or act. No matter how we define the value of a reward (and there has been a long-standing controversy surrounding the precision with which utilities can be specified), the behavior of rational man can be prescribed once these values are known.[2]

Just as important as these prescriptions, however, is the method which game theorists have devised to describe the range of possible behaviors (rational and otherwise) in any given situation. This method is the game matrix, which simulates all of the possible choices for all parties in the situation and the outcomes or consequences of the available choices. In games of strategy (in contrast to games of skill or chance) we may have "pure" or "mixed" strategies reflected in the game matrix. The former term indicates a strategy (sequence of choices) selected before the beginning of play which specifies the move to be made in any situation, while a mixed strategy specifies the probability of any move given more than one possible pure strategy for the player. Depending on the rules of the game (which indicate whose move it is, choices available, and which situations signify a game's end), there may exist for each player either a pure or a mixed strategy which is optimal, that is, one which yields the best payoff (expected value) in a statistical sense over many trials.

Finally, games of strategy are classified according to the number of players (actors, participants, agents) involved--two-person and n-person, and according to the opposition of interests of the players--constant sum or nonconstant sum games. In constant sum games the interests of the players are diametrically opposed, since any payoff received by one necessarily reduces the payoff of the other(s) (if the payoff is equal to each other player's loss the game is "zero

sum"; if the reward-loss continuum is not symmetrical but constant the game is "non-zero sum"). On the other hand, in nonconstant sum (often called mixed motive) games, the interests of all players are partially opposed and partially congruent, a situation more representative of real life conflict. If the strategies of players in nonconstant sum games are "joint" (i.e., if they satisfy the interests of other players in consideration for reciprocal choices on their opponents' part), the game is cooperative; otherwise the game is noncooperative. The more prominent cooperative solution theories of conflict resolution are those of von Neumann and Morganstern (1967), Nash (1951), Shapely (1953), Harsanyi (1962), Aumann and Maschler (1964),[3] Rapoport and Chammah (1965),[4] Shubik (1970).[5]

Since the publication of von Neumann and Morganstern's fundamental treatise on game theory, both the nature of research and the scope of application of game theory as a mathematicized strategic science has broadened. Investigation has centered, for the most part, however, on determining optimal strategies which can be prescribed in two-person constant sum games in which important conflicts are bipolarized. Such research is reported in Kuhn and Tucker (1953),[6] Luce and Raiffa (1957),[7] Schelling (1960),[8] Drescher, Shapely, and Tucker (1964),[9] Schubik (1964),[10] Rapoport and Chammah (1965),[11] and Swingle (1970).[12]

Communication:

Few communication researchers have pursued game theory empirically. Within the context of game theorists' own research, however, three distinct thrusts to the study of communication related behavior during conflict conditions (in contrast to pre-game or intra-side communication) are evident. (1) studies of coalition formation; (2) studies of bargaining over allocation of rewards and

losses; (3) studies of the effects of communication on game behavior. This research is reviewed in Steinfatt and Miller (in press).[13] A careful reading of these investigations suggest potential benefits in such a theoretic and methodological approach for our field. Specifically, four advantages accompany the adoption of a game theoretic perspective in communication research.

First, it is possible to investigate communication as a process. Despite emphasis on the dynamic, continuous, and processual nature of communication (cf. Berlo, 1960;[14] Brooks and Scheibel, 1968;[15] Mortensen, 1972;[16] Miller, 1973[17]), most researchers in our field persist in static designes for tests of communication variables. What could be less processual than the typical persuasion research paradigm in which subjects are pretested, assigned to treatment groups, asked to read or listen to a single message and then to present but one response to the stimulus (usually on a paper-pencil test). The processual fidelity of measurement of several variables in a posttest design, or a posttest plus repeated measures design, is little better. Nor is this relatively static nature of research limited to our discipline. Woelfel (1971)[18] has argued that the rejection of an Aristotelian conception of motion in the physical sciences finds no parallel in the development of most of the social sciences. Rather than emphasizing continuous change in behaviors (expressed as rates of change and changes in rates of change), behaviors are often conceptualized and usually operationalized as discrete and discontinuous. The consequence of this reliance on differences between treatment groups at one point in time, or differences across only two or three points in time, is the loss of the use of two of the most powerful tools in mathematics--the continuous variable and the continuous function.

Game theory, however, facilitates continuous process research to the extent that rates of behavior (dependent measure) can be observed over trials per game

and over games per opponent (or across opponents), while messages, payoffs, and opponent characteristics are manipulated independently or simultaneously. Furthermore, message transmissions are not restricted to a single, uni-directional stimulus; in game simulations it becomes possible to study extended series of communicative interactions. Though the game paradigm may not capture the process concept in its entirety, certainly it is more dynamic than the static designs presently employed in communication research. This topic is treated in greater detail in the concluding section of this paper.

Second, by means of the game matrix one can simulate within an experiment situations in which communication functions as an essential determinant of behavior. Specifically, games allow us to specify players' rewards and losses, to observe Ss behaviors which result in gains and losses, to study the effects of power on behavior (i.e., matrices can be constructed to simulate situations we face daily in which the rewards a subject perceives are partly dependent on his own choices in that situation but also dependent on the choices of others), and to investigate the uses and results of communication in such situations. Simons (in press)[19] and Miller (1973) have written that communication researchers have largely ignored the threats and inducements which, in real conflict situations, buttress the logical and emotional appeals of influence attempts (e.g., order effects, sidedness, evidence, credibility, etc.). They argue that we ought to be concerned with more than drawing room controversy. We concur; when subjects receive messages concerning toothbrushing, civil defense, the war in Vietnam, or the desirability of admitting only upperclassmen to a university, there is a lack of situational immediacy. Usually there are no behaviors to be engaged in which will produce real gains or losses in their present situation and/or which subjects perceive as valuable. However, if subjects' rewards are substantial

amounts of money, points on a midterm exam, or an opportunity to lessen the hardship of prison life, such rewards are likely to be worthwhile for subjects and the game matrix allows us to simulate conditions in which communication has consequences for behavior and attainment of such rewards, but in a controlled laboratory setting. To be sure, the "real world" provides another set of such situations, but the difficulties in achieving internally valid results and systematically varying the phenomena of interest rule out many, if not most, such situations as a basis for knowledge which is cumulative and both internally and externally valid.

A third advantage of the use of game simulations in communication research is the concomitant ability to observe and measure precisely behavioral choices dependent on manipulated variables. As suggested by the italicized words, three subpoints bear mentioning here:

(1) First, if our goal as social scientists is to build theory which accurately explains and predicts patterns underlying the complex communicative behaviors we experience, then the precision of our theory will be dependent on the precision of our measurement. Theory and measurement are inextricably interwoven, since the precision with which a functional relationship between two or more variables can be stated is itself a function of the degree of precision with which those variables can be measured. The point here is that the game matrix provides an analytic, mathematical tool for the study of functional relationships between communication and rates of cooperative and competitive behaviors--precisely measured.

(2) Woelfel underscores the importance of behavioral choice in social science research:

> "The problem of behavioral choice, that is the situation in which an individual is faced with a set of alternative possible behaviors from which he must choose, has been central to the social sciences from their inception, in economics as choices among alternative goods and services, in political science as alternative political actions such as voting, and more generally in psychology, sociology, and communication as individuals faced with any set of alternative actions they might perform. Most of the areas of

concern to the social sciences may be expressed in the language of behavioral choice, ..." (p. 3-4).

Game theory permits us to study the effects of communication on such choices in real reward situations.

(3) Finally, the concern with behavioral choices in game theory permits us to sidestep the painful attitude-behavior discrepancy which has limited the generalizability of much communication research. It becomes unnecessary to ask if attitude responses predict future behaviors, since the behavioral choices made in the game are a direct index of behavior when the rewards have real value for the subjects. Thus asking a subject how he will behave (cf. Fishbein, 1973),[20] or asking for a statement of beliefs on a seven point scale, are not a necessary part of a gaming experiment. On the other hand, a game situation also provides an excellent opportunity to investigate the attitude-behavior problem (cf. Ajzen, 1971),[21] for subjects can be asked how they intend to play and this measure correlated with the actual behaviors evidenced in the game.

The fourth potential benefit of game simulations for communication research is the need they provide for a clear definition of communication and how it differs from other forms of behavior. Steinfatt and Miller (1974) have presented a definition which hinges on the concepts of information and consequences. As defined, communication takes place when the probability of occurrence of a given behavior is changed as a result of symbolic exchanges which in and of themselves carry no consequences for the situation. This definition is explicated fully in the source cited previously. Suffice it to say here that the definition has three noteworthy characteristics: (1) it is behavioral in that it determines the occurrence of communication on a publicly observable basis--probabilities of behaviors must be altered; (2) it distinguishes between communication behaviors and all other behaviors on the basis of situational consequences--communication does not result in irreversible situational consequences; (3) communication is symbolic and ambiguous--it does not carry with it an irrevocable commitment to a given move (nor the consequences of that move). The definition is not perfect,

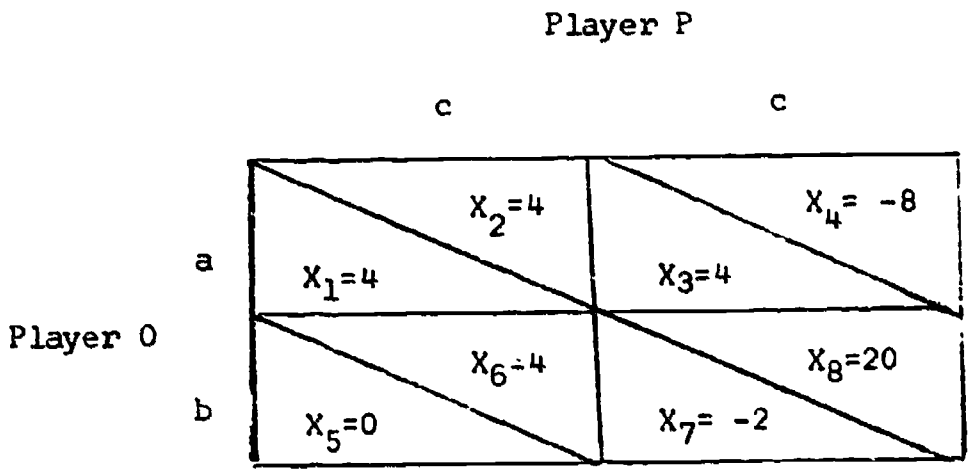
since there are border-line cases which are difficult to classify. However, its potential importance rests on the direction it points toward the central thrust of our discipline: it directs our attention toward methods and means of producing real behavioral changes in the parties to any conflict via proposed move sequences (communications) which carry no necessary consequences for the situation.

Creative Alternative Game:

Steinfatt (1972)[22] has developed a game with which to study the effects of communication in simulated conditions. Called the "Creative Alternative Game (CA), we have used it in several studies to assess the influence of such variables as communication and dogmatism on players' ability to arrive at an optional game strategy. This research is summarized below. First, however, we turn to the distinguishing characteristics of the CA game. The payoff matrix for the CA game is shown in Figure 1. According to Steinfatt:

> A CA game may be defined as a matrix in which (a) there exists only one rational choice for one player (O) but a mixed motive situation for the other player (P); (b) but the choice of his best move by O must result in only one rational choice remaining for P; (c) the payoff for both players for this semi-forced solution must be equal; (d) the total payoff to both players must be a maximum when both fail to choose their rational alternative (for P this means the alternative which is rational when O chooses rationally) and should be on the order of twice the total payoff available from the mutual rational choice cell; and (e) neither player has fate control over the other if the othe other chooses his rational alternative. Symbolically this may be expressed as $X_1=X_2=X_3=X_6$; $X_1>X_5$; $X_1>X_7$; $X_1>X_4$ $(X_7 + X_8)>2X_1$.

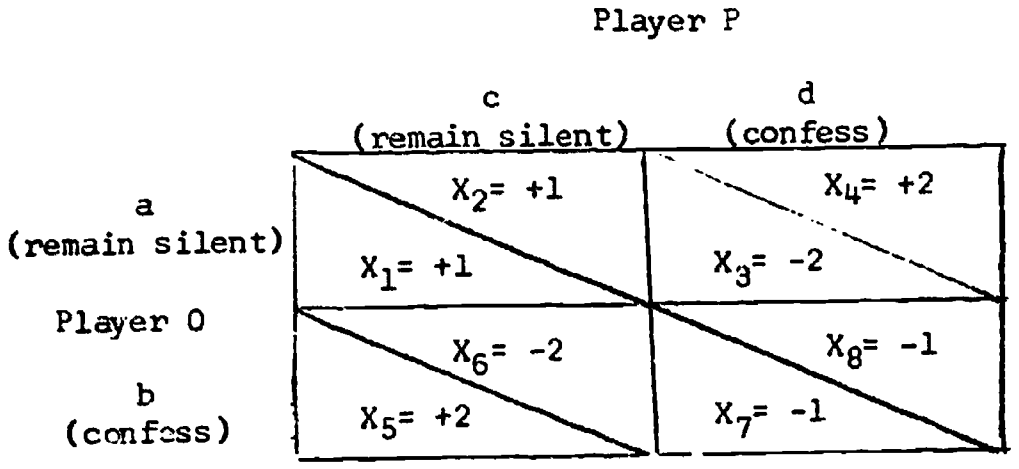
Figure 1: CREATIVE ALTERNATIVE GAME MATRIX



Steinfatt contrasts the Creative Alternative game with a traditional game used by game theorists in studying conflict resolution--the Prisoner's Dilemma. The typical payoff matrix for a PD game is depicted in Figure 2 below.

> The CA game is quite different from a PD game. First, it is not semetric since the payoffs are not the same for P and O. Secondly, either player in the CA game can guarantee himself a payoff of 4 units by making choice a for Player O or choice c for player P (this is not possible in PD, where O's reward for choice a will be different if P chooses c or d). . . . The third major difference of the CA game from a PD game is that one of the cells contains a joint payoff which is greater than the sum of the payoffs for the obvious choice (ac) cell."

Figure 2: PRISONER'S DILEMMA MATRIX



The CA game is an attempt to model the type of situation where collusive crime may occur. Collusive crime (crime without a victim) is a situation in which two or more persons illegally enter into a mutually beneficial agreement which increases the total payoff to the coalition in one of two ways: (1) if the situation is defined as constant sum, with "the house" as a player, the gain to the coalition produces a loss of like amount to the house; (2) if the situation is viewed as variable sum the increased payment occurs at no one's expense, resulting instead in increased utilities to both players. Examples of (1) might be the "spiff money" offered by some stereo and high fidelity equipment manufacturers to salesmen and retail outlets to push their products or to give them favorable display space. Examples of (2), depending on one's point of view, might be the paying of a fee to a prostitute or buying a nickel bag of marijuana. The house is not usually represented in the CA matrix but is the source of the actual payoffs in the (1) situation.

An important feature of the CA solution (the bd cell) is that collusive crime must be self-generating. It must occur without any hint or encouragement by anyone other than the parties to the agreement. The value of the payoff to both parties should be that at least one of the parties is able to see the possibility of such an arrangement without receiving outside information that such a solution exists. For such a situation communication between the parties will be of maximum importance. That is, unlike the PD game, in which the matrix itself dictates the strategy which will yield the highest rewards for both players have determined this fact and agreed to cooperate, the CA game yields maximum rewards to both players only if they agree to side payments and to form a joint strategy which has no rational basis and would not be possible consistently without communication. Miller (1973) points out the importance of communication in

the CA game and its potential in commun cation research:

> When communication is allowed. . . the potential exists for a persuasive attempt. This potential arises because one of the cells in the matrix (the bd cell) yields a higher payoff for both players than the rational choice (ac cell) if they reach an agreement on side payments. In order to reach this creative solution, its existence must be: (1) deduced from observation of the situation by at least one of the players . . . and (2) be communicated to the other player in such a way that (3) the second party is willing to admit the possibility of its existence, and (4) perceives its increased benefits for him, and (5) is willing to trust that the first player will not take advantage of the situation, to the extent that (6) the second play actually engages in the proscribed behaviors in conjunction with the first player.
>
> The underscored conditions 5 and 6 comprise the heart of the persuasive task. Assume that P is cast in the role of persuader and O in the role of persuadee, . . . P must persuade O to perform the b response, at a cost of two units of reward, so that P may play d and garner 20 units. To accomplish this persuasive goal, P may use the inducement of a split of 20 units with O, thereby assuring a greater payoff for each player than if both play the rational choice, ac cell. However, O must be persuaded that P will actually split the 20 units, for the game is played in such a way that P is not compelled to split the take....Should P persuade O to perthe irrational response and then refuse to split the take with him, O stands to lose a great deal, ...
>
> In a nutshell, I believe that the Creative Alternative game provides a potentially viable alternative paradigm for the study of many aspects of the persuasion process.[23]

Hence, the CA game allows us tc study traditional communication variables which one player uses to persuade the other to a side payment, how his arguments are received, interaction concerning reward splits, and any threats or inducements which accompany messages from any player and at any point in the game. Actually, the number of variables which can be investigated is unlimited. For example, we may examine how individual difference variables affect a player's susceptibility to persuasive influence in the CA game (e.g., dogmatism, Machiavellianism, tolerance of ambiguity, risk-taking, etc.); message strategies over time (via content

analysis of the communication of two naive subjects, or the effects over trials of a confederate's predetermined persuasive appeals or responses); how variations in magnitude of rewards affect game behavior; and, interactions among these classes of variables. Several possibilities for future research are made explicit in the concluding section of this paper. Before moving to these proposals, we will review our previous research in which both the PD and CA games have been employed.

Research:

During the past two years, the authors and a colleague have conducted research on communication in game simulated conflict situations involving 84 undergraduates in two studies by the second author at the University of Michigan, 92 undergrad Ss in speech-communication classes at SUNY Buffalo, and 21 inmates who were members of a college level speech course taught by the first author at a federal prison in Michigan. Independent variables have been type of situation simulated (PD or CA game), player characteristics (e.g., sex of each player, and dogmatism levels), duration of communication allowed (full, delayed, none), and nature of rewards (real vs. imaginary); dependent variables have included cooperative behavior (in both the PD and CA games), creative solutions in the CA game, and players' apportionment of game rewards. This research has been reported in piecemeal fashion with the conclusion of each study and for different audiences.[24] What follows is but a brief outline of the major results from these studies, presented for the first time in some unified fashion. Readers interested in the theoretic rationale for these variables are directed to the research cited above, where extended discussions are offered. Our research indicates that:

1. Under real reward conditions, immediate communication between players (but disallowed after the first 12 trials) produces more cooperative responses in a PD game than does delayed communication (i.e., communication allowed only between trials 13 and 24). However, both immediate and delayed communication produce significantly more cooperative behavior than a no communication situation.

2. In a PD game in which the possibility of sidepayments has been made explicit, the effect of real rewards over imaginary rewards seems to be to create more pairs which respond completely cooperatively, and to increase only slightly the level of cooperation in pairs that choose a competitive strategy initially.

3. In a PD game, the highest level of cooperation over all trials is found under conditions of real reward and full communication (usually between 80% and 85%). With real rewards but no communication, cooperation drops to about 30%, which is not different from the finding of 30% to 40% cooperation typical in PD games of imaginary reward and no communication. Thus there seems to be no main effect for real over imaginary rewards.

4. The existence of communication in a PD game (with either real or imaginary rewards) does produce an apparent main effect over no communication.

5. In both the PD and CA games, communication appears to interact with rewards to produce an even higher level of cooperation than is achieved with full communication alone, and although communication has an effect in imaginary reward situations, its major effect is reserved for those situations where the rewards are real.

6. In both the PD and CA games, pairs not achieving consistent ac cooperative responses tend to interrupt those choices with only an occasional b or d moves rather than a burst of competitive responses. Often this is in the no communication condition where, according to post-experiment interviews, boredom and restlessness seem to motivate the players to break the pattern in which they find themselves.

7. In the PD game, no major sex differences were found for number of cooperative choices either across or within communication conditions (however, since only 48 trials were run, this is in accord with Rapoport's finding that sex differences do not emerge in runs of less than 100 trials).

8. In the CA game, high dogmatic persons are significantly less likely to achieve a creative solution (more than three consecutive bd responses) than low dogmatic subjects under conditions of full communication and real reward. In fact, we have yet to find a high dogmatic pair who seemed even to recognize the possibility of side payment.

9. When communication has not been allowed in a two-person CA game, the creative solution has never been achieved. Under full communication

conditions, there have also been several instances in which one member has identified the mutual advantage of adopting a bd strategy with side payments but has been unable to persuade the other player to adopt a joint strategy.

10. In the CA game, both communication and low dogmatic persons in the P position have been found to be necessary, but not sufficient conditions for reaching a creative solution. Once reached, that solution tends to be fairly stable and does not end when communication is disallowed.

11. The split of side payments from the creative solution in a CA game usually begins with P proposing a 10-10 split, but O counters with a proposal of 11-9 thereby equalizing each players' payoff at 9 points (to correct for the 2 point loss sustained by O with any bd response). While P may persist in attempting to persuade O to accept a 10-10 split, usually an 11-9 equal apportionment is the final decision.

Conclusion:

As noted above, an interaction between reward conditions and communication conditions is suggested when data from all the experiments are compared. Under conditions of highly restricted communication, real reward does not seem to produce a level of cooperative response which is substantially different from that found under imaginary reward conditions. But when full communication is allowed, real reward produced more communication than imaginary reward. This apparent interaction is in addition to an apparent main effect for communication across reward conditions. Thus the significant effect for real over imaginary reward found in one of the studies, and cited above, is best regarded as a simple effect under full communication rather than as a true main effect. However, we plan to test these propositions in a single experiment rather than in the comparison of results across different studies.

In one of our experiments we examined the effect of communication on a situation which simulated the type of environment which may result in collusive crime: a desired goal is obtainable if one person can convince another that the goal can, in fact, be obtained. At least two variables seem to be related to

this process according to the results in our experiments. First, communication is necessary, for without communication no creative solutions can occur. Second, the personality variable of dogmatism seems to be related to the ability to achieve a creative solution in a CA game. Does this mean that dogmatism is related to the probability that an individual will engage in collusive crime? To the extent that dogmatism is a person's openness to new information and to new ways of thinking, perhaps it is related. Persons low in dogmatism may be more successful in completing a belief change process which proceeds collusive crime than are high dogmatic persons.

However, the action of the dogmatism variable may be more complex than this simple statement. Previous research[25] has indicated that dogmatism has its strongest effect when very high credible and very low credible sources are used. Highly dogmatic individuals tend to act in accord with statements originating from very positive (for them) sources and against statements from negative sources significantly more often than their low dogmatic counterparts.[26] That is, high dogmatic persons are more easily influenced by people they consider authority figures than are low dogmatics. It would seem that if the authority figures for a high dogmatic person were urging him to enter into collusion with them that he would be more likely to do so than would a low dogmatic person in the same situation. Yet, our research indicates that low dogmatic subjects seem more capable of reaching a creative solution in the CA game than do high dogmatic subjects. If authority figures were urging the high or low dogmatic person <u>not</u> to engage in a particular collusion, we would expect a high dogmatic to follow their advice more often than the low dogmatic person. In this case we would expect more collusive actions by the low dogmatic subjects and fewer by the high dogmatic persons. If the authority figures were urging collusion,

it would be difficult to predict a difference between subjects based on dogmatism since the source argument would predict more collusion by high dogmatics, while Rokeach's Denny Doodlebug[27] analogy of a belief change process would predict more collusion by low dogmatic subjects. Thus, further research on dogmatism in simulations of collusive crime is needed before any strong conclusions are drawn concerning its effects.

Finally, research on the effects of communication must begin to examine some of the more subtle communication variables. The definition of communication offered above provides a method of differentiating communication from a move in game situations. The effects of different types of messages from sources with certain personality, attitudinal, and cultural makeup on receivers with various attributes can be studied in terms of changes in game behavior under real reward conditions. Situational variables such as power may be examined in a game, thereby allowing researchers a look at persuasive variables that are difficult to study outside a game situation. For example, fear appeals have not clearly distinguished between a threat in which the source controls the means by which the action suggested in the message will be carried out, and a warning in which the source is acting as an information agent with no power to influence the act mentioned in the message. On the positive side, a similar distinction may be drawn between promises and recommendations. What are the effects of these types of communications? Are they the same in all situations, or are they influenced by the power, rewards, personality, attitudes, and past experiences of the parties to the situation? We hope to answer these questions in future research with game simulations.

NOTES

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